Issues for satellite simulators

Robert Pincus
University of Colorado and NOAA/Earth System Research Lab

Issues for ~~satellite simulators~~ observation proxies

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Given a desire to compare model prediction with observations we require proxies for observables far from model state

Distance can be in terms of

- state vector
- spatial or temporal scale
- sampling conditions
- temporal or spatial aggregation strategy

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see also: data assimilation
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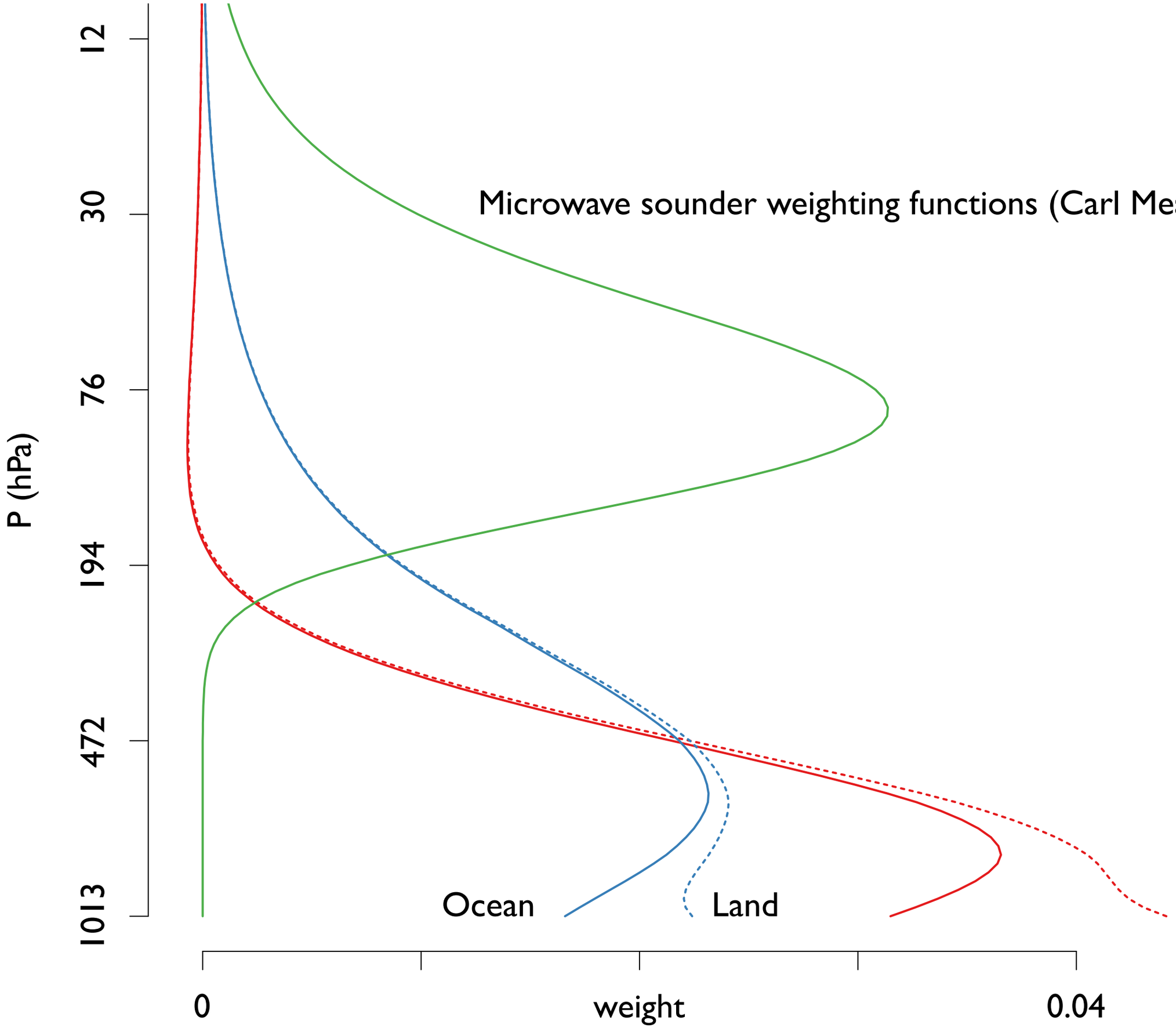
observation operator

temporal or spatial aggregation strategy

statistical comparisons are unique to climate models

Microwave sounder weighting functions (Carl Mears)



What we've learned from the cloud experience

The retrieval/signal debate may be a red herring…

… but vertically-resolved obs still aren't well-exploited

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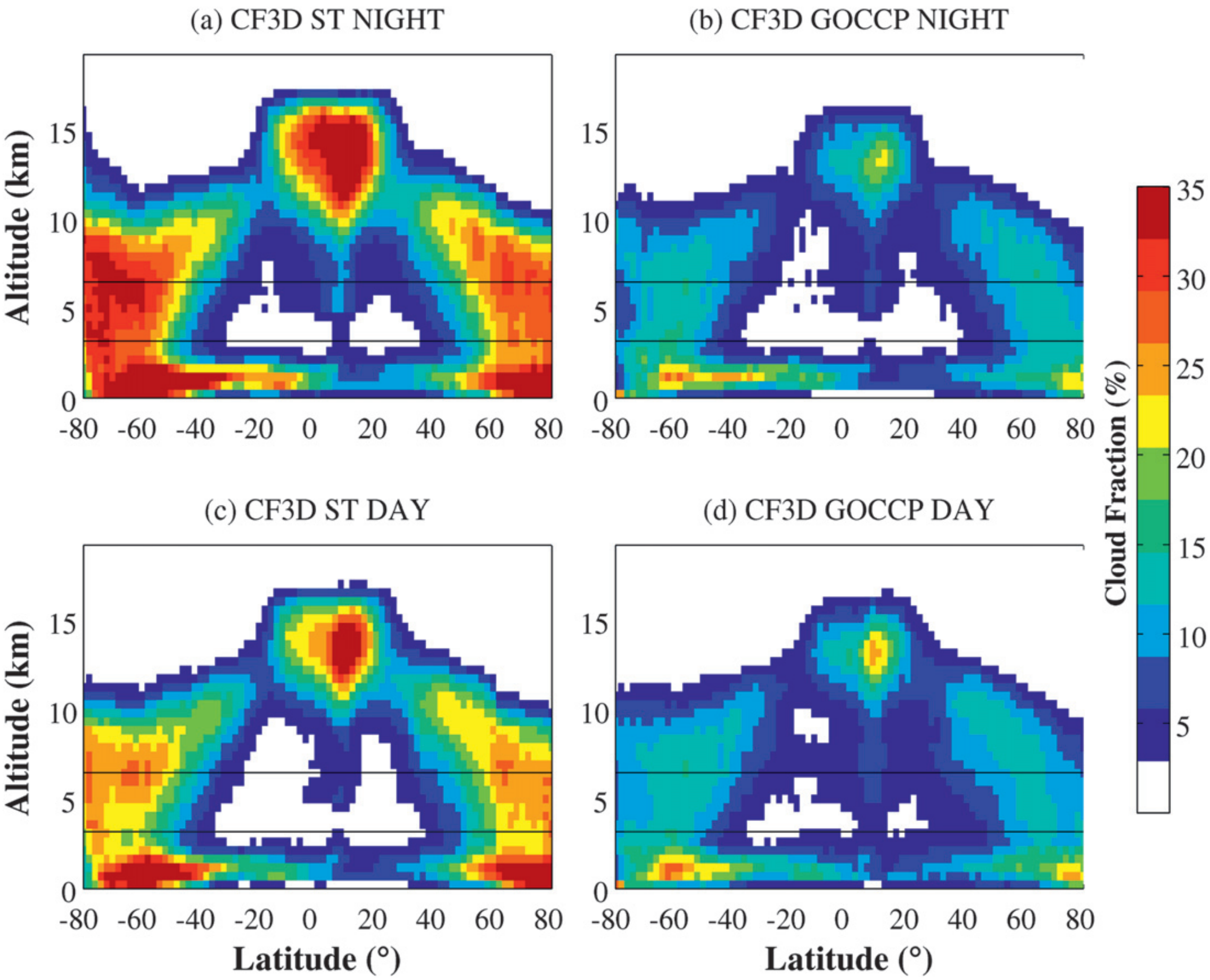
Even with proxies the "best" observations may not be optimal for comparison to climate models

"… a data set (GOCCP), that diagnoses cloud properties from CALIPSO observations exactly in the same way as in the simulator (similar spatial resolution, same criteria used for cloud detection, same statistical cloud diagnostics). This ensures that discrepancies between model and observations reveal biases in the model's cloudiness rather than differences in the definition of clouds or of diagnostics."

Chépfer et al., (2010), 10.1029/2009JD012251



Chépfer et. al (2013), 10.1175/JTECH-D-12-00057.1

What we've learned from the cloud experience

The retrieval/signal debate may be a red herring…

… but vertically-resolved obs still aren't well-exploited

Even with proxies the "best" observations may not be optimal for comparison to climate models

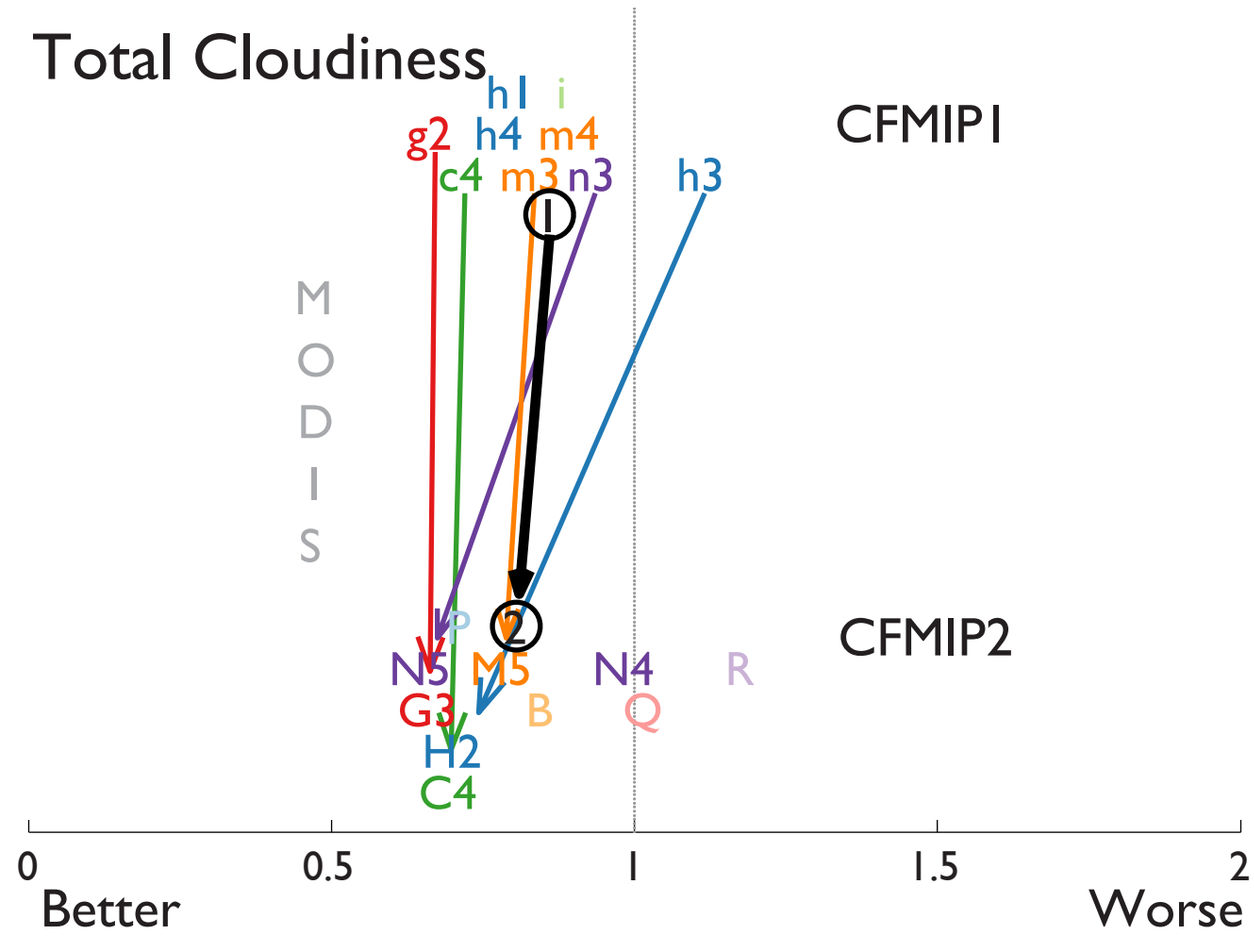
Proxies can have unforeseen benefits

Results from the ISCCP proxy are useful for radiative diagnosis

The examined aspects of models (sometimes) improve

The distribution of clouds generally improved in individual models between CMIP3 and CMIP5

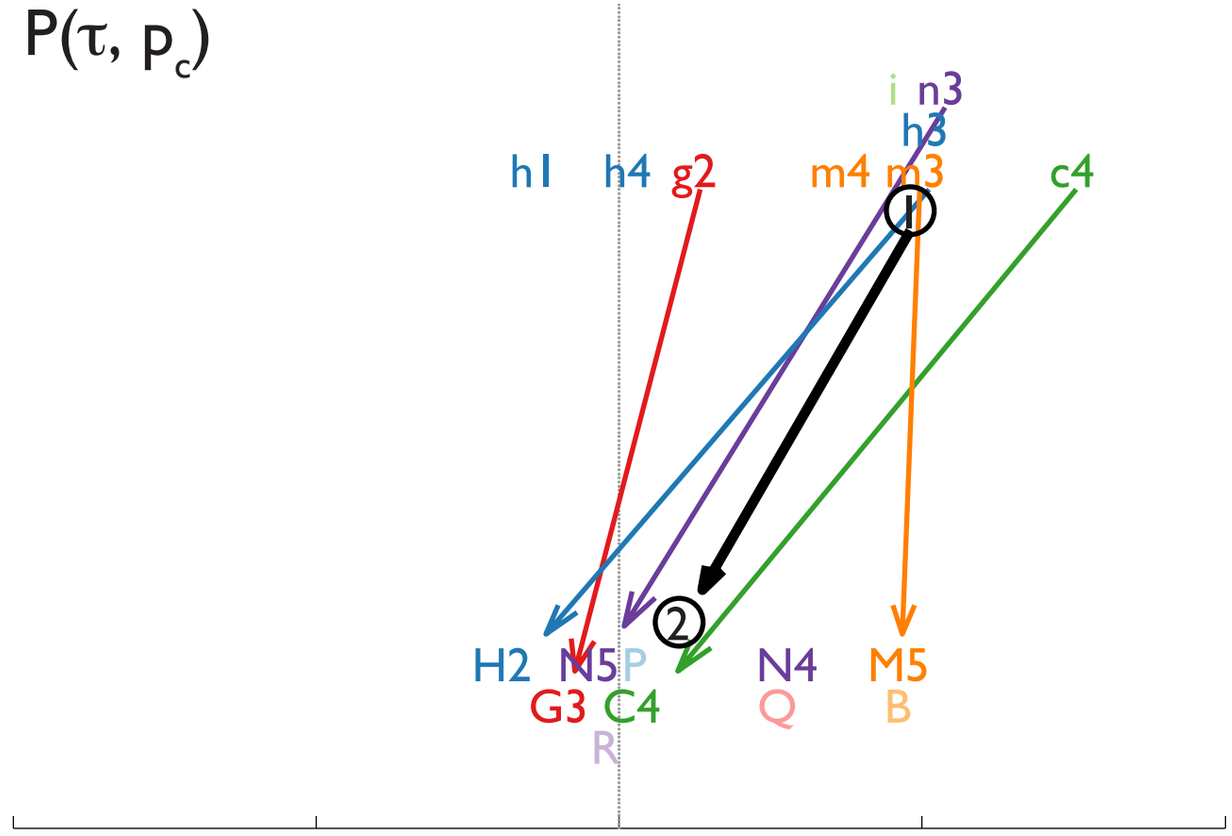
Total Cloudiness



CFMIP1

CFMIP2

$P(\tau, p_c)$



Klein et. al (2013), 10.1002/jgrd.50141

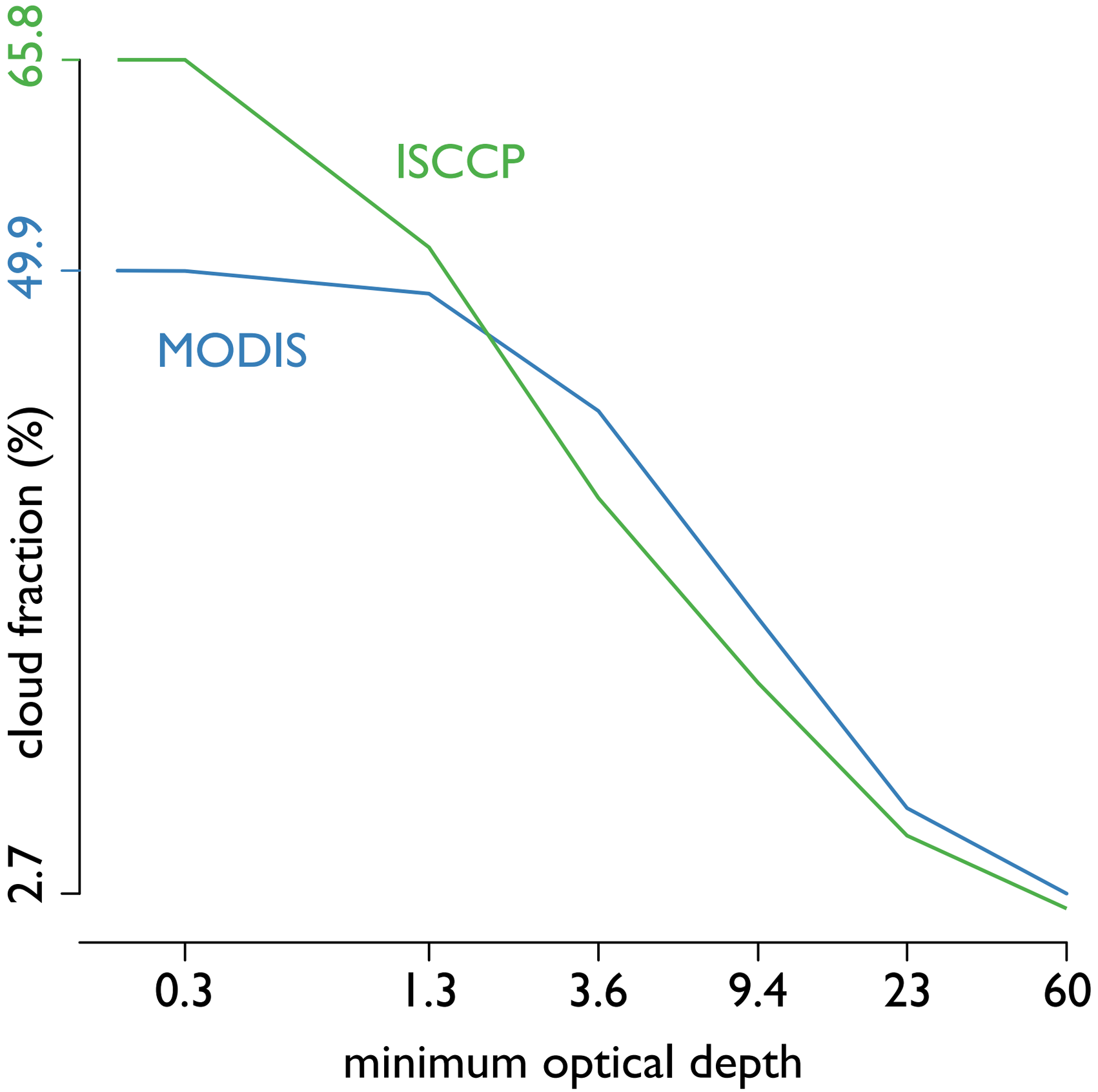
Challenges (i)

Information central to simulate signals is limited in climate models

diagnosis of assumptions isn't so interesting

Many known imperfections in the observing process are omitted

e.g. geometric dependencies, uncertain ancillary information



Pincus et. al (2012), 10.1175/JCLI-D-11-00267.1

Challenges (i)

Information central to simulated signals is limited in climate models

Diagnosis of assumptions isn't so interesting

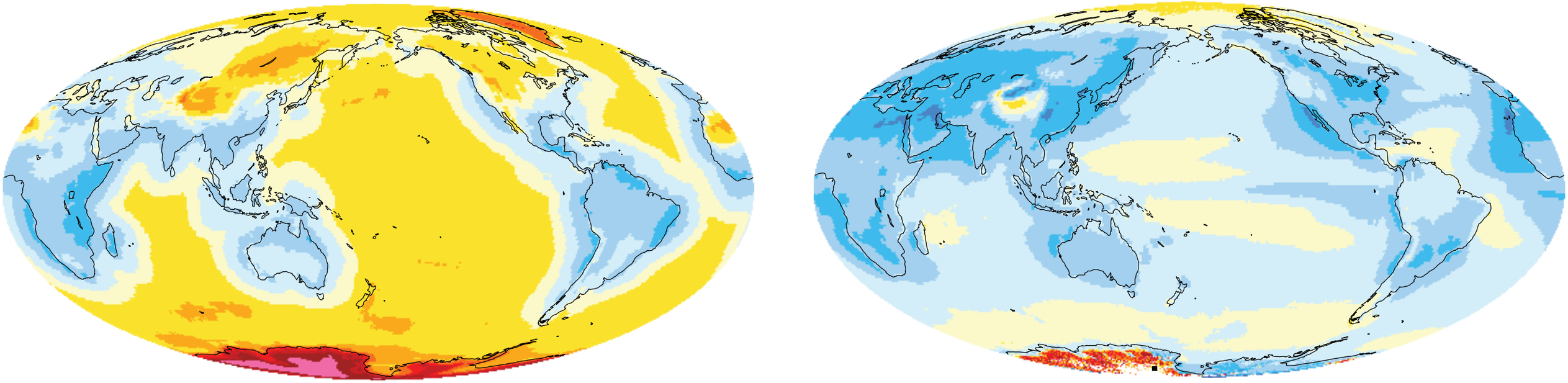
Many known imperfections in the observing process are omitted

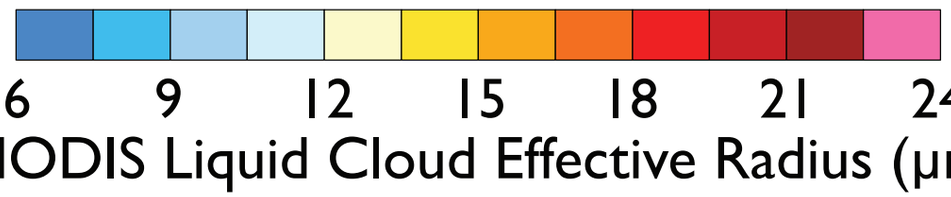
e.g. geometric dependencies, uncertain ancillary information

Many limitations of the observing process are not well-understood

CAM4: global mean 13μm

CAM5: global mean 11μm

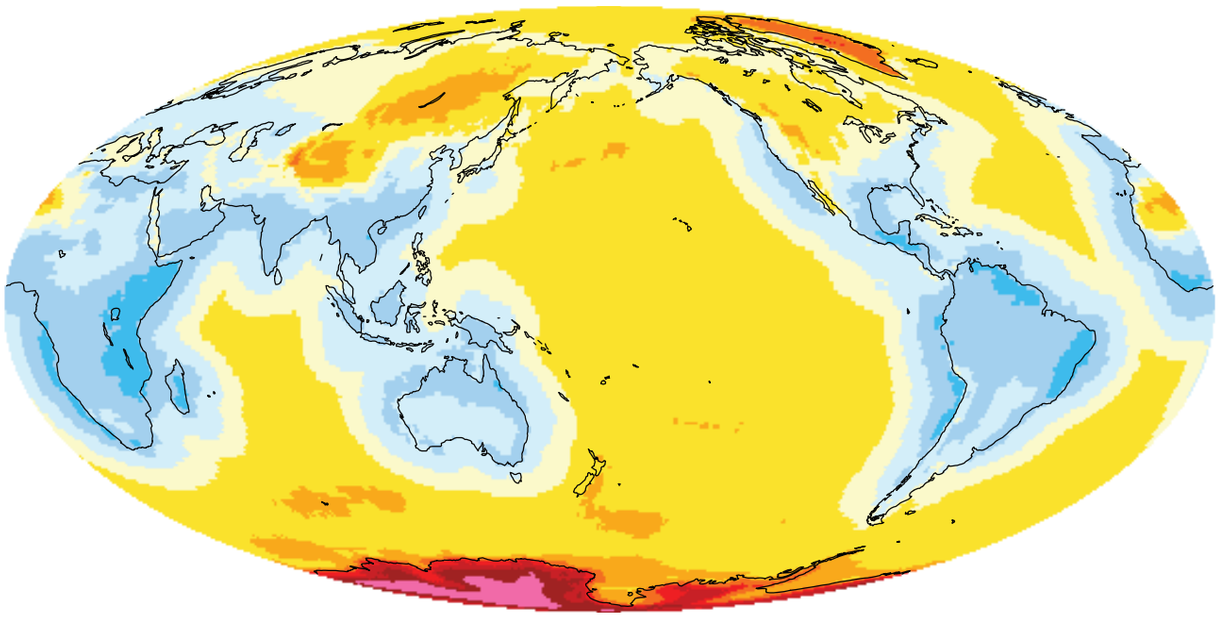




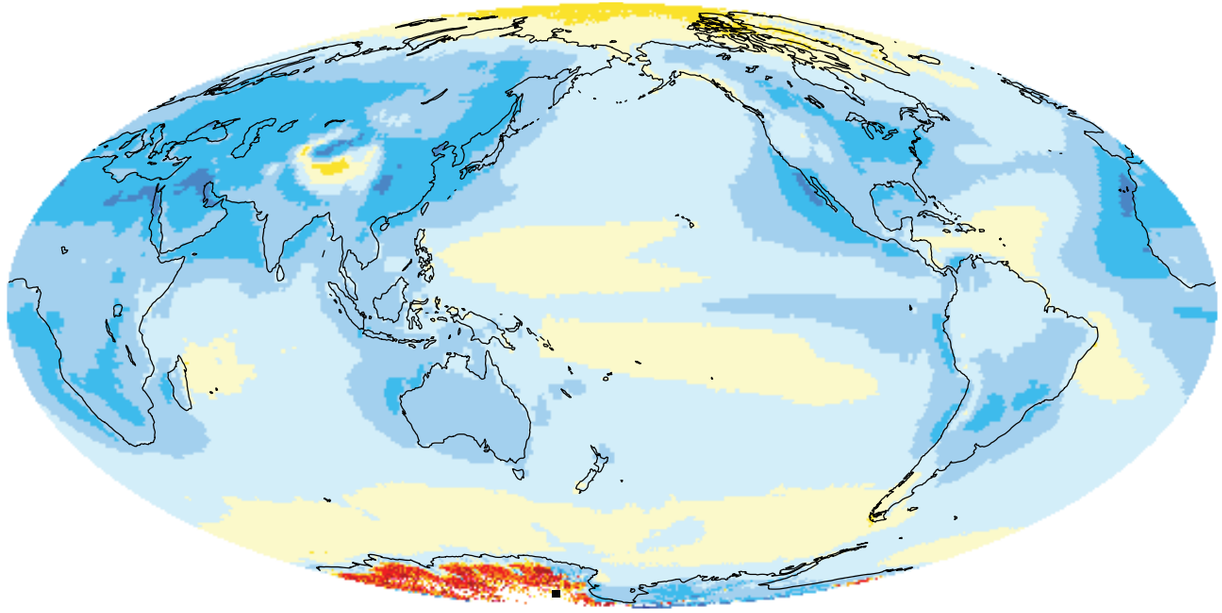
MODIS Liquid Cloud Effective Radius (μm)

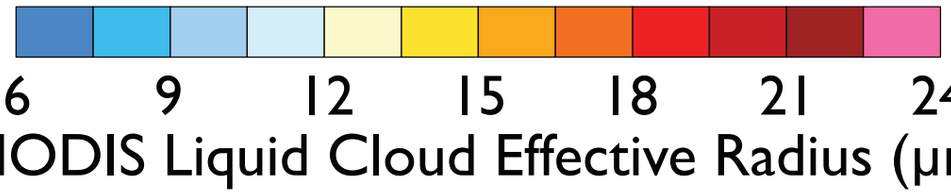
Kay et. al (2012),
10.1175/JCLI-D-11-00469.1

CAM4: global mean 13μm



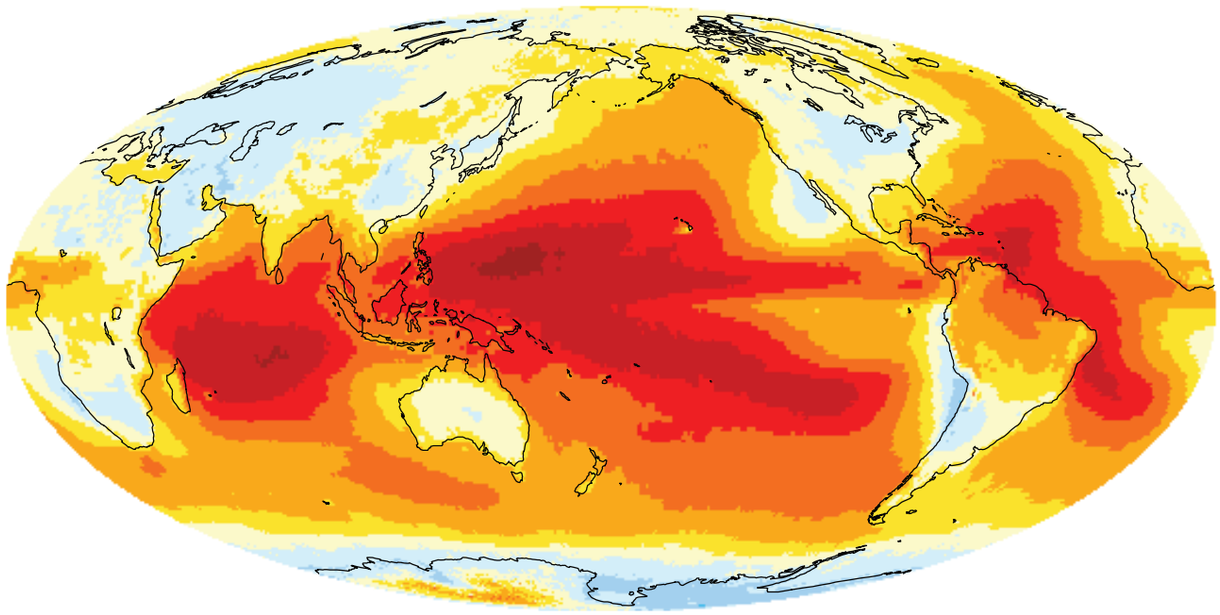
CAM5: global mean 11μm





MODIS Liquid Cloud Effective Radius (μm)

Observations: global mean 16μm



Kay et. al (2012),
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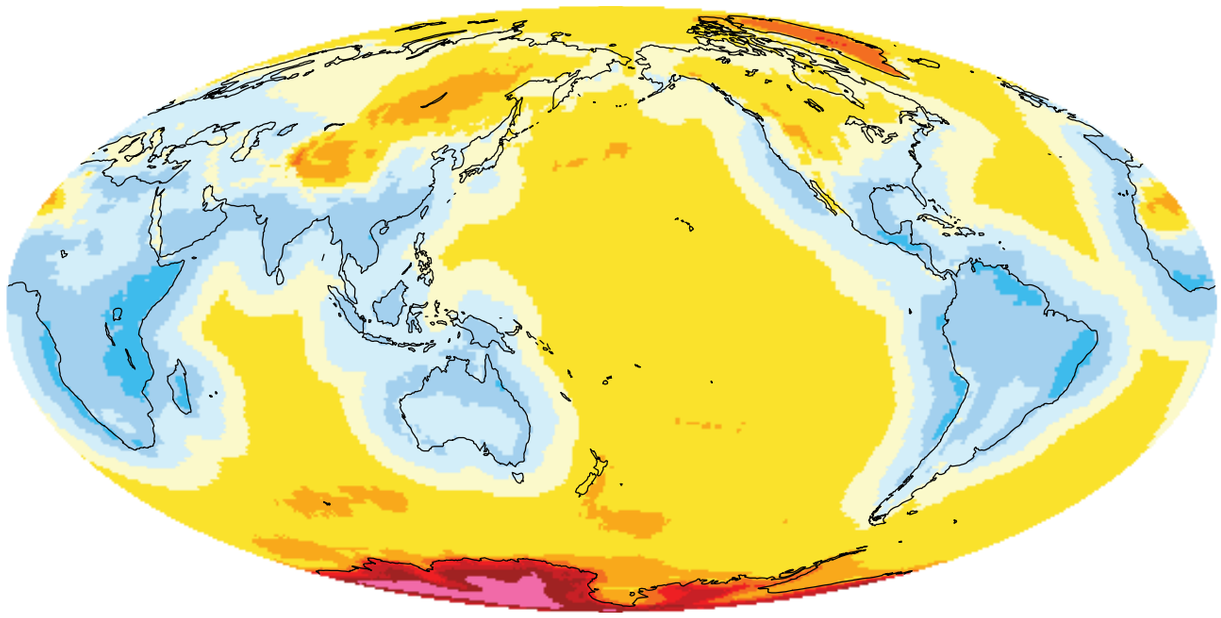
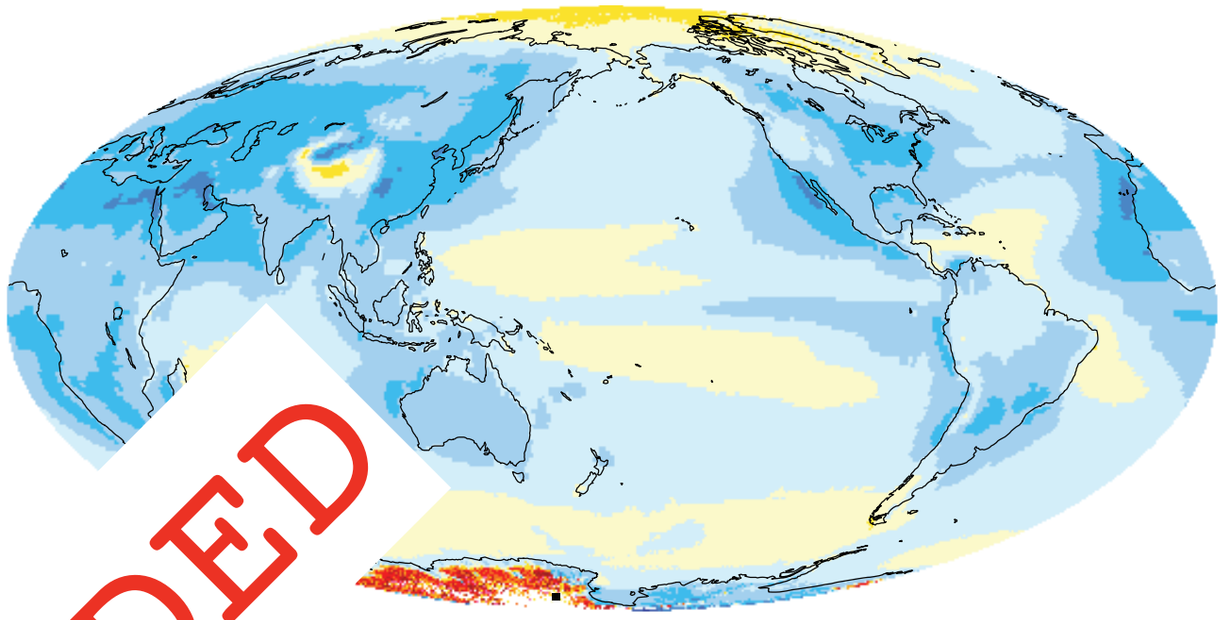


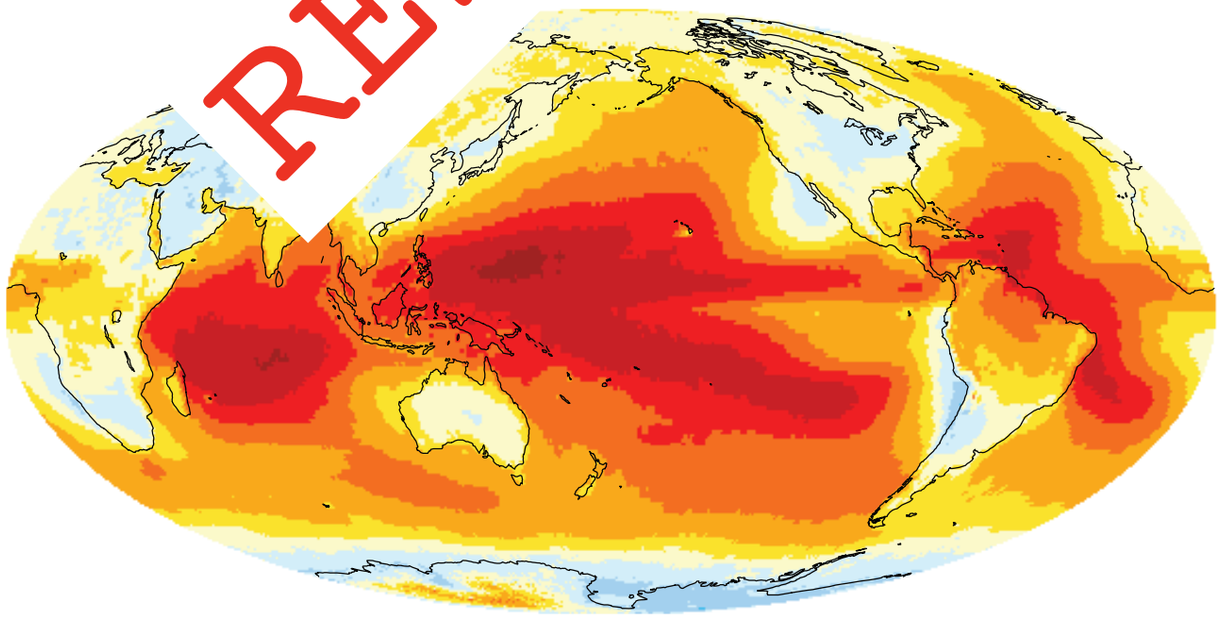
CAM5: global mean 11μm



MODIS Liqu[illegible]ive Radius (μm)

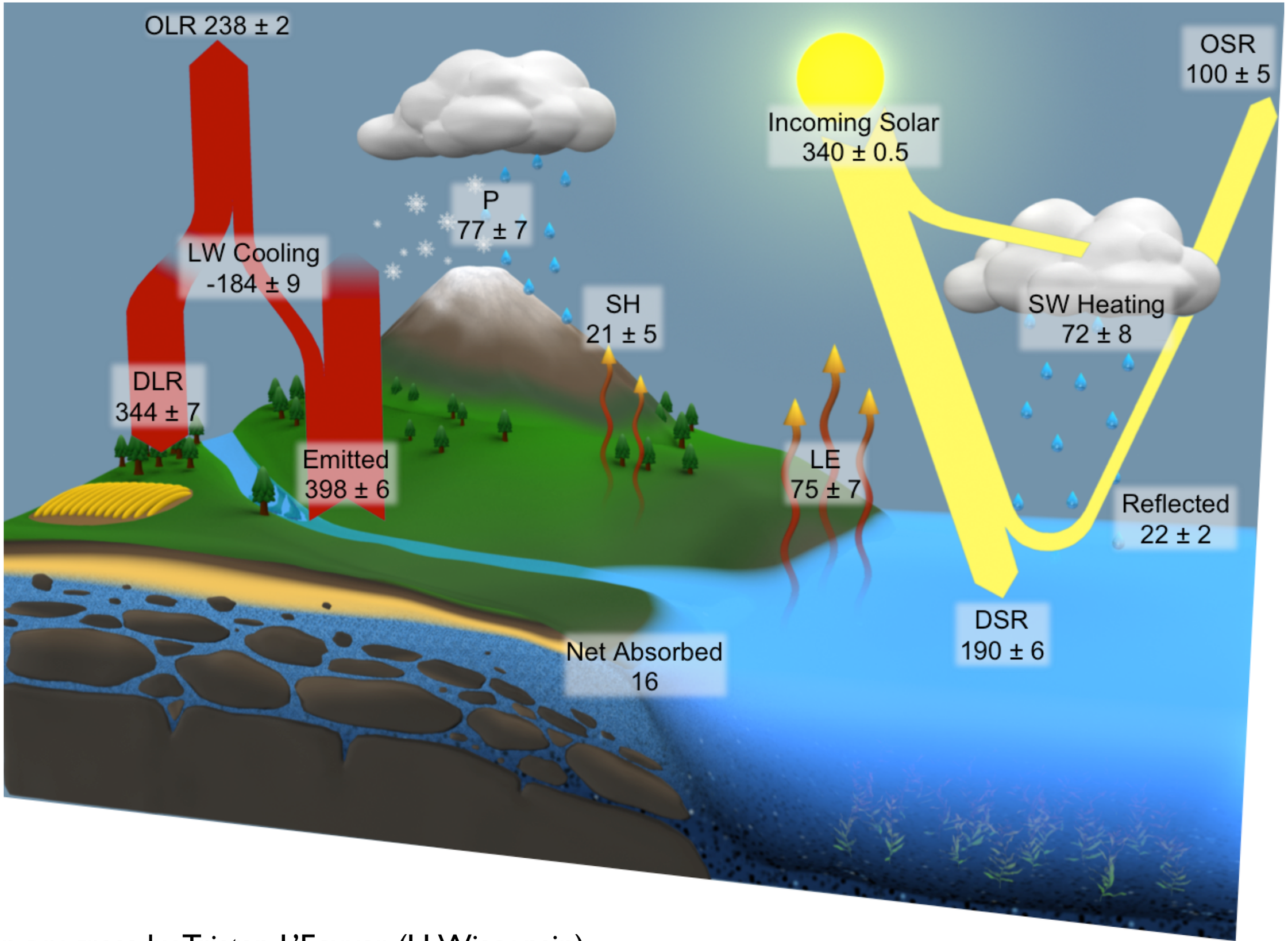
RESCINDED

[illegible]lobal mean 16μm



Kay et. al (2012),
10.1175/JCLI-D-11-00469.1

The observed energy budget isn't balanced



Work in progress by Tristan L'Ecuyer (U. Wisconsin)

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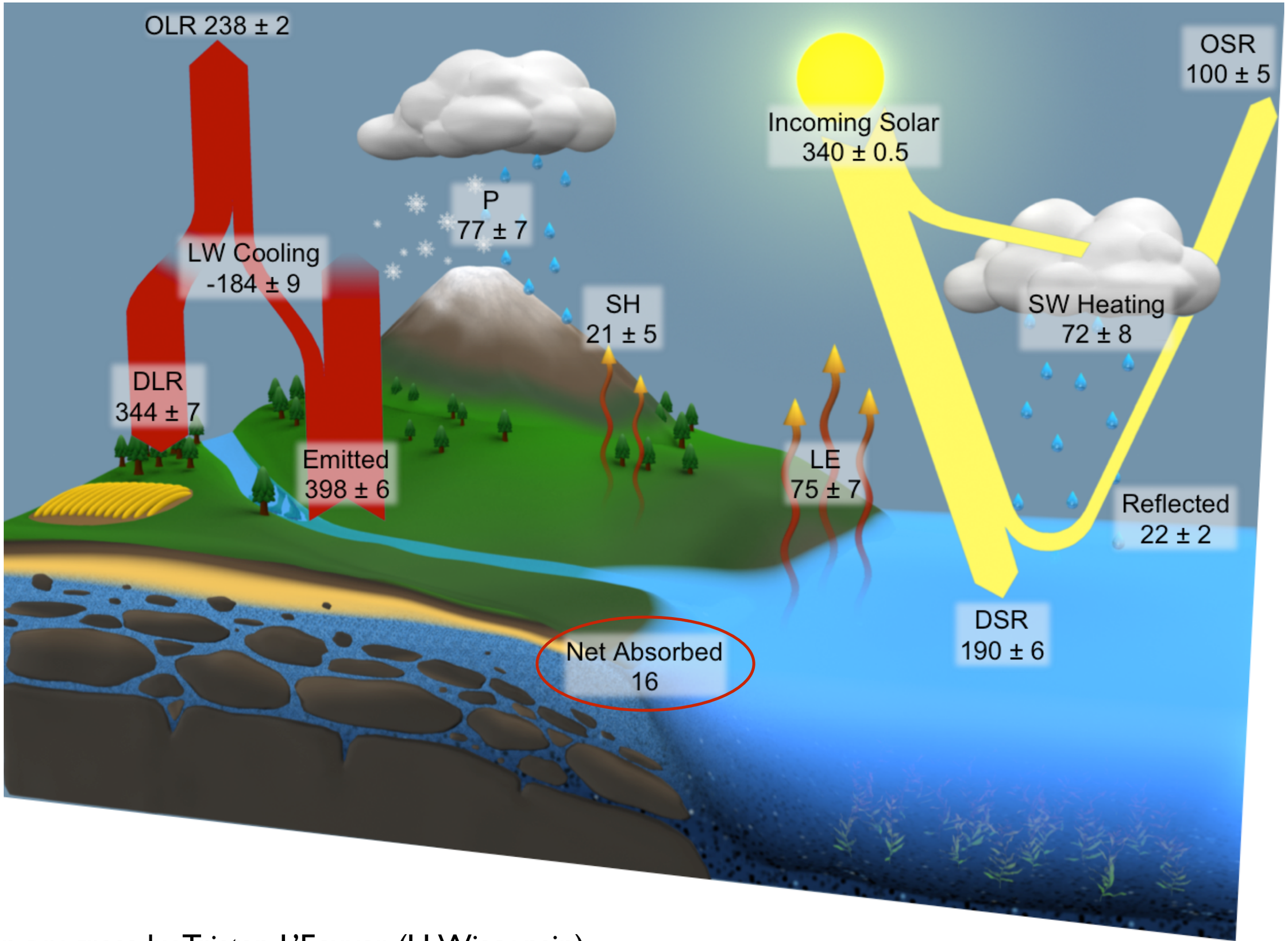


Work in progress by Tristan L'Ecuyer (U. Wisconsin)

Challenges (ii - representing uncertainty)

Where models are close to observed climatology, error and/or uncertainty estimates for aggregated quantities become crucial

We have a long way to go

most of the error and uncertainty in retrievals comes from systematic, conditioned failures of interpretive models not captured by proxies

even when the uncertainty in individual retrievals is well-understood we lack statistical models for uncertainty in aggregate estimates

Opportunities

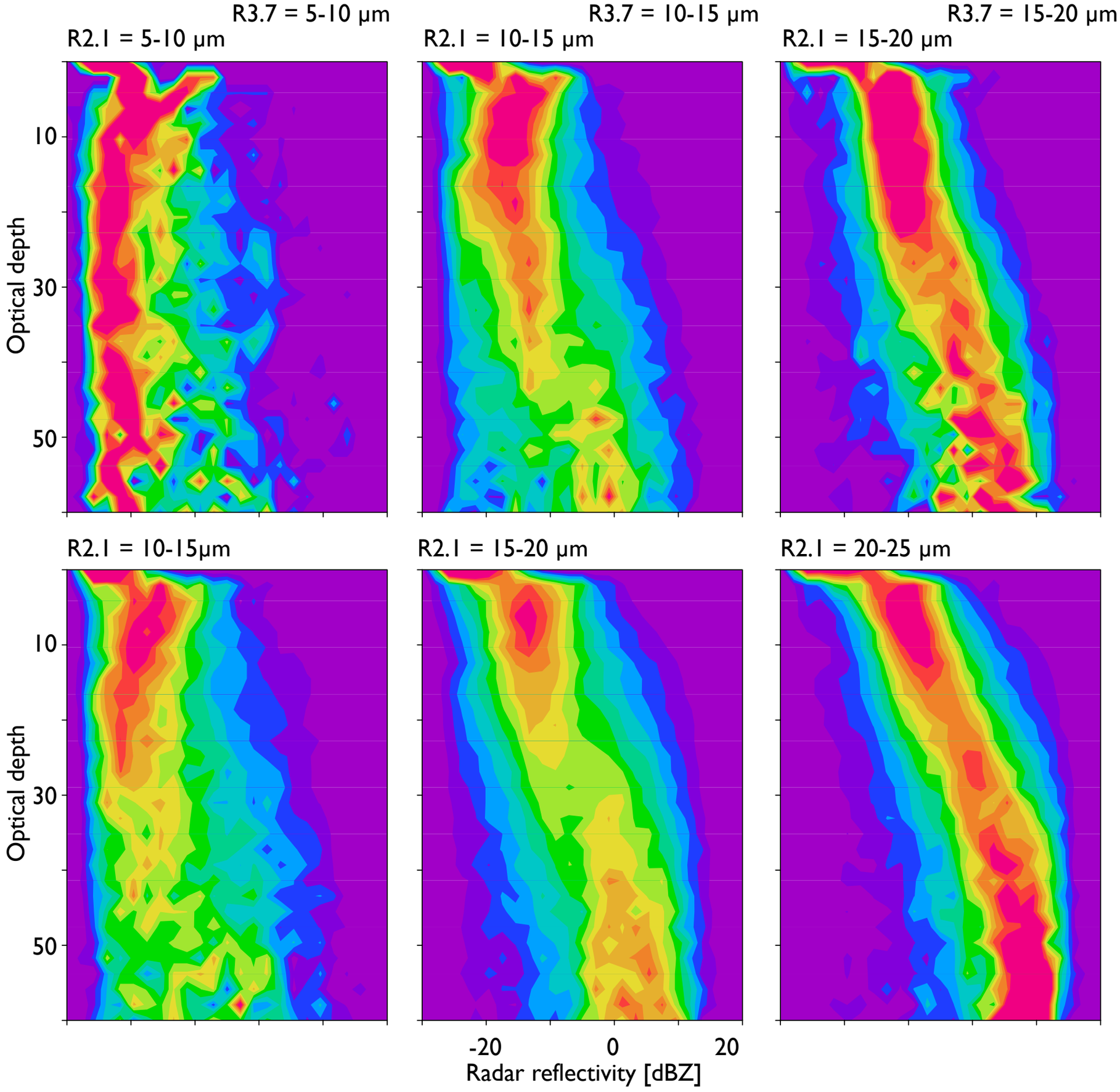
New proxies won't get traction unless they add useful insight

Atmospheric state is well-observed

Opportunities for improving process understanding

thoughtfully-partitioned analyses of existing proxies (high freq.)

multi-sensor analyses of existing (and new?) proxies



after Suzuki et al. (2010), 10.1175/2010JAS3463.1

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multi-sensor analyses of existing (and new?) proxies

proxies for process-relevant observations

e.g. water isotopes from spectra (TES, etc.)

Proxies for coupled system

e.g. sea surf. salinity (Aquarius), land hydrology (GRACE)